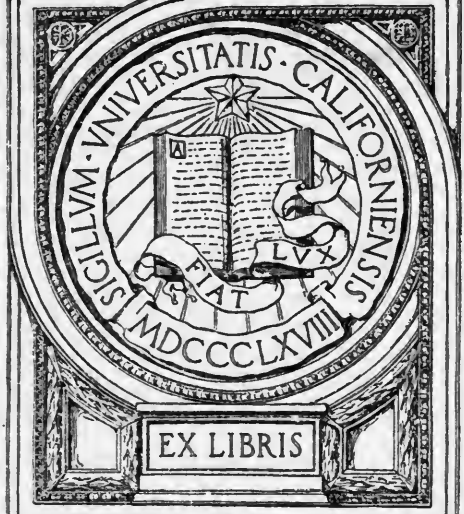

United States Department of Agriculture,

BUREAU OF SOILS—CIRCULAR No. 17.

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MANURIAL REQUIREMENTS OF THE PORTSMOUTH SANDY LOAM OF THE DARLINGTON AREA, SOUTH CAROLINA.

The Portsmouth series of soils, of which the Portsmouth sandy loam is the most extensive type, occurs mostly along the outer edge of the Atlantic Coastal Plain, occupying level, slightly depressed areas in the uplands. The soils are the result of sedimentary deposits modified by swampy conditions, which have in recent times been lessened by the establishment of better drainage.

The Darlington area of South Carolina, lying wholly within the Coastal Plain, is situated northeast of the center of the State and includes all of Darlington County and a part of Lee County. Its climate is mild, with a well-distributed rainfall ranging from 40 to 50 inches annually. For further information relating to the soils and agriculture of the area, see Soil Survey of the Darlington Area, South Carolina, Field Operations of the Bureau of Soils, 1902, pp. 291–307. In that report Portsmouth sandy loam is described under the name of Goldsboro compact sandy loam, a name which has since been discarded. It is the most extensive and important soil type of the Darlington area, embracing an area of about 118,000 acres. It is also the least understood soil of the area, considerable of it being uncultivated and only indifferent yields being secured from most of the fields under cultivation.

The soil used in the wire-basket tests, the results of which are reported in subsequent pages, was collected from one of the best farms in the Darlington area. Before selecting the location for sampling, a detailed soil map of the whole farm was made and the fullest possible information obtained in regard to its past history and the methods in use under its present management. The owner and manager of this farm is looked upon as one of the most up-to-date and successful farmers of Darlington County, and inspection of his farm and the measure of success attained will justify such a statement. It will be interesting, therefore, to note the following brief sketch of the historical and natural features of this farm, and the reader may also profit by the methods that have been recently used to increase the productivity of the soil.

HISTORICAL.

The farm, consisting of about 430 acres, is situated about 6 miles east of Darlington, the county seat. The first fields were cleared from the virgin forest growth at least seventy-five years ago, and, being natu-

rally fertile, at first gave abundant yields; but, as the forest mold became exhausted and the yields steadily and rapidly decreased, new fields were cleared as rapidly as possible and the least productive old ones thrown out of cultivation. The chief crop interests, as at present, were cotton and corn. With the abundance of land then available and under the conditions of labor then existing this system of farming was profitable and the planters enjoyed a high degree of prosperity. With the change to a paid-labor system, the scarcity of new lands, and the improved methods of cotton culture came the necessity of a radically different system of farming. The methods in use in the past for the culture of cotton and corn are too much a matter of history to require description, but the methods in use at present will be fully described. The beginning of marked improvement dates back about twenty-five years, with the introduction of cowpeas as a soil enricher, and to this medium, combined with crop rotation, deeper plowing, and more thorough cultivation, most of the improvement is ascribed.

At the close of the early system the fields were for the most part so run down as to produce not more than one-half bale of cotton per acre, and many had long since ceased to be profitable; others had suffered from washing because no labor to care for them was to be had. As a consequence it has been no easy matter to bring them to their present improved condition.

The growing of bright tobacco is an industry of comparatively recent introduction and the most approved methods are in use with this crop, under the personal supervision of the planter.

SURFACE FEATURES AND DERIVATION OF THE SOILS.

The farm presents on the whole very level surface features. The cultivated fields change but a few feet in elevation, and that but rarely. However, a variation of 1 foot is often sufficient to produce a marked change in soil. Open ditches are cut in the depressions wherever necessary to secure adequate surface drainage, and tile underdrainage will be necessary to secure the best results with many fields. The slopes to the stream bottoms are quite abrupt, descending from 15 to 30 feet, with the crest of the descent often marked by a slight ridge or rise occupied by one of the lighter colored, better drained soil types. The stream bottoms are subject to overflow in seasons of high water and are, therefore, largely uncleared.

The principal drainage is in a general southerly direction into Black Creek. The inclination of many of the fields is so slight that the surface water may be carried in almost any direction at will.

The soils, with the exception of those lying in the stream bottoms, are derived from unconsolidated marine sediments of comparatively recent age and present a variety of texture ranging from a heavy silt

loam to a loose coarse sand—changes from one extreme to the other taking place rapidly and within narrow limits. The dip and depth from the surface of the clayey stratum which underlies most of the area at no great depth are of prime importance in its bearing on the crop interests of the overlying soil, as this stratum forms the moisture reservoir, and where more than 3 feet from the surface the lands are poorly suited to the general crops of the section. On the other hand, where it approaches within a few inches of the surface on level lands, the soils without special treatment are poorly suited to any but the grass and small grain crops.

MANAGEMENT OF PLANTATION.

The agricultural methods in use on this plantation differ in many respects from the general methods of the community and have been found in practice to give uniformly better results. When the present owner took charge of the place several years ago many of the fields were in poor yielding condition, and the surface soil was very shallow. By gradual and careful deepening of the preparatory plowing, a systematic rotation of crops, and the continued use of cowpeas in the rotation the soil proper has gradually deepened, until it now averages about 7 inches in most of the tilled fields and is quite mellow and loamy in character. In increasing the depth of the seed bed not more than one-half inch of the subsoil was turned up at any one plowing, in order that the yield should not be decreased in any one season by the addition to the surface soil of an excessive proportion of unweathered materials. The aim has been to follow as closely as possible the following rotation: Beginning with corn for the first season, two rows of cowpeas are sown between the corn rows at the time of last cultivation, from which the vines are harvested for fodder, the roots alone remaining to improve the soil. The second season the same field is planted in oats sown the fall of the preceding season, followed by a crop of cowpeas after the crop of oats is harvested, the vines in this case also being gathered for fodder. The third season cotton is grown with, possibly, a single row of some smaller variety of cowpea sown between the cotton rows in the early fall, from which the vines are not gathered, but left to be plowed under in the preparation for the fourth season. The fourth season the field receives the same treatment as in the third, thus giving a four-year rotation—corn, oats, cotton, and cotton, with at least two, and possibly four, crops of cowpeas. This is the system practiced on lands not suited to the type of tobacco grown here, and when tobacco does not enter the rotation. On the tobacco fields a different procedure is necessary to preserve the required thinness of the leaf. Beginning with tobacco the first season, cotton follows the second. The field is allowed to lie idle the third, producing a crop of weeds which is plowed under for the benefit of the succeeding crop of tobacco, making a three-season

rotation—tobacco, cotton, and fallow. It should be mentioned here that no crop of cowpeas is sown in this rotation, not even in the cotton.

Cotton is planted from April 15 to April 30, about 1 inch deep in rows 5 feet apart, which have been bedded by plowing several furrows toward each other, and if the crop succeeds another cotton crop the new beds are made in what were the furrows of the previous season. The fertilizers used are mixed on the place from the simple ingredients and usually consist of cotton-seed meal, acid phosphate or dissolved bone, and sulphate of potash, so combined as to give a percentage of from 6 to 8 of phosphoric acid, 3 of ammonia, and 3 of potash. Of this mixture, about 800 pounds per acre is used—500 pounds at time of planting, under the seed, and 300 pounds as a surface application about June 15. The manner of applying varies somewhat with the season, and sometimes a top dressing of about 60 pounds per acre of nitrate of soda is used. One row of dwarf cowpeas is planted between the cotton rows at the last cultivation, or about the middle of July, and the vines left on the ground.

Corn ground is prepared by plowing in beds 6 feet wide, then one furrow is plowed back from each side and the planter run in that. Seed is planted 2 inches deep in rows 6 feet apart, and thinned to 18 inches apart in the row with one stalk in a place. The level of the corn rows is at least 6 inches below the general level of the field. Fertilizer of the same composition as that used on cotton is applied to the corn at the rate of about 600 pounds per acre, but none is applied at the time of planting. The corn is planted about April 1, and the first application of 200 pounds of fertilizer is made beside the rows from May 20 to 30. When the corn is about 2 feet high, another 200 pounds of fertilizer is used, and the soil is plowed in toward the rows. The third application of 200 pounds is made the latter part of June and more soil plowed in. Early in July 100 pounds of nitrate of soda is applied, and a little later two rows of cowpeas are planted between the corn rows. This method is used by only a few planters in this section, but they are satisfied that the resulting yield is nearly, if not quite, double that secured in the usual way.

Oats generally follow corn, and are drilled in at the rate of 3 bushels per acre, the latter part of October, the ground being plowed to a depth of about 7 inches with a disk plow. No fertilizer is used, except a top dressing of about 75 pounds per acre of nitrate of soda given in March, and the crop is harvested in June, followed by a crop of cowpeas.

Bright tobacco entails a highly specialized treatment, and, as it is not within the scope of this investigation, no detailed description will be given. About 1,000 pounds of high-grade mixed fertilizer is used in addition to 2 two-horse loads of stable manure per acre. The lighter soils are used for this crop, and no attempt is made to increase the

yield of cotton which follows it on the same fields, as this might result in detriment to the next tobacco crop. Thorough cultivation is given all crops.

The conditions obtaining on this plantation are fairly illustrative of the great advances made by the best farmers in this section of the South in the last few years.

The residence is a spacious and comfortable two-story frame house, approached by a magnificent avenue of Darlington oaks, and has an extensive lawn of Bermuda grass well laid out and relieved by shrubs and flower beds. The house is thoroughly plumbed, water being furnished in ample quantity by a windmill.

The outbuildings and vegetable garden are in the rear of the house. Good stable accommodations are furnished the stock, and the tools are fairly well housed. The commissary shop, smokehouse, guano-house, packhouse, gin, mill, and various store and curing houses for the tobacco complete the buildings equipment. The cabins of the principal servants and laborers are near by, while the rest of the field help are located on rented tracts surrounding the area under consideration. With the exception of the overseer, who exercises personal supervision over the details of the field operations, the rest of the labor employed is colored. The average wage is about 50 cents a day.

The live stock consists on the average of 7 horses and 6 mules, which are stabled, 15 head of cattle pastured during the day and stabled nights, 25 head of swine penned at night, and about 30 hens. Only a small part of the manure is saved and no special pains taken to prevent waste of even this amount. The want of economy in this particular is fully realized and steps will soon be taken to remedy it. The amount of poultry kept is not an indication of the extent of that form of husbandry in the locality, as it forms a large item with many farmers.

The adaptation of certain soils to particular crops has been well recognized. The soils of the Norfolk series from their lighter and better drained features have been used principally for bright tobacco in the rotation mentioned in a preceding page, the adaptation of the better drained Portsmouth types to oats and grain crops has been taken advantage of, while the heavier and poorly drained soils have been utilized for Bermuda grass, pasture, or left uncultivated until opportunity offered for their improvement. Ridges of lighter, better drained soil and spots of heavy, poorly drained phases occur in nearly every field, and their textural and drainage differences are reflected sometimes to a marked degree in the resulting growth. Where no textural differences are apparent to account for the difference in productiveness, the presence of a compact sand hardpan obstructing drainage or an inclination of the clay substratum allowing too complete drainage is sufficient to account for the observed differences.

Yields of cotton on this plantation do not vary much from 1 bale per acre on the average for a good season, but this yield is never far exceeded. Average yields of corn are from 60 to 70 bushels per acre, and of oats about 60 bushels, although yields of from 80 to 100 bushels are occasionally secured.

A greater diversification of crops and the introduction of some grasses suited to this climate would be of much benefit. Bermuda grass is grown to some extent and furnishes good pasturage while green, but dies down and lies dormant during a portion of the year. It is an excellent medium to arrest and prevent washing or gall spots.

The California or bur clover grows naturally to some extent, but is of little value except as a soil improver, for it dies early in the summer and is little relished by stock. Many roots of this plant were examined and were found uniformly to possess nodules, so it evidently has some power of nitrogen fixation and may be of benefit to succeeding crops.

PARTICULAR DESCRIPTION OF THE SOIL TESTED.

As stated in the beginning of this circular, the Portsmouth sandy loam is the most extensive soil type in the county, and it is also an important type on this farm. The soil of Portsmouth sandy loam, as it occurs here, extends to an average depth of 7 inches and is a dark-brown or gray sandy loam, mellow and friable when dry, but compacting when wet on account of its rather high silt content. The sand particles are sharp and rather coarse. The subsoil is much more sandy, but sticky and plastic and gray or pale yellow in color to a depth of 18 to 21 inches, where it grades rather abruptly into a mottled yellow and drab sandy clay which is very sticky and impervious to water.

The greater part of this type lies in the eastern part of the farm. Its surface features are very level—so much so that standing water remains on the undrained fields after heavy rains, making a naturally cold, wet soil. Underdrainage will be necessary with many fields before they can be brought into the best condition. The sandy layer between soil and deep subsoil is very apt to compact to such an extent as to become almost a hardpan, and where present to any extent decreases the crop yields.

Like the Norfolk types, this soil is derived from marine sediments, but owes its present condition more to the result of long-continued swamp conditions. The color of the soil is due to accumulation of organic matter; that of the subsoil immediately underlying it to a bleaching by the organic acids liberated from above; while the drab and mottled colors of the substratum give evidence of the slight extent to which atmospheric weathering has proceeded.

Throughout the county cotton will average from one-third to one-half bale per acre, corn from 10 to 20 bushels, and oats about 25 bushels.

On this plantation much has been done toward the improvement of this type with a large measure of success, and there is no reason why yields of as much as 1 bale of cotton, 40 bushels of corn, and 50 bushels of oats per acre should not be secured generally throughout the county by proper treatment. The soil is perhaps better adapted naturally to the production of oats than to any other crop commonly grown here.

RESULTS OF DIFFERENT MANURIAL TREATMENTS OF PORTSMOUTH SANDY LOAM.

The soil used in this test was a composite sample of about 500 pounds. It was taken to a depth of 7 inches, which is the present depth of cultivation, and was considered thoroughly typical of this soil. An acre from which this sample was secured was reserved for use in field demonstration of such treatments as might give very beneficial results.

The method consists in growing wheat for a period of twenty to twenty-five days in small wire baskets, which, after being filled with soil and planted with wheat, are sealed with paraffin, so that practically no moisture is lost from the soil except through the transpiration of the wheat. By periodically weighing the baskets and adding distilled water from time to time a favorable moisture content of the soil is maintained. At the close of the experiment the plants are cut and weighed, so that both the green weight of plants and the water used in the course of growth are ascertained for each treatment. Under the conditions of the test the draft made upon the soil by the plants, even for so short a period, is greater than that which occurs in the field during the full growing season.[1]

In the first test of this soil 20 manures and fertilizers, or combinations thereof, were given in comparison with the untreated soil, there being 5 baskets for each treatment. The table on the following page gives the treatments for those which produced a marked increase in growth, together with the comparative weights of the plants, those from the untreated soil being taken at 100.

[1] For fuller description of the method see Circular No. 15, Bureau of Soils, U. S. Dept. of Agr.

Relative growth of wheat plants on Portsmouth sandy loam with various treatments.

Fertilizing materials and quantity applied per acre.	Relative growth.
Untreated	100
Cowpeas, 5 tons, + lime, 2,000 pounds	238
Sodium nitrate, 200 pounds, + potassium sulphate, 200 pounds, + acid phosphate, 200 pounds, and lime, 1,000 pounds	207
Sodium nitrate, 200 pounds, + potassium sulphate, 200 pounds, + acid phosphate, 200 pounds, + lime, 2,000 pounds	205
Cowpeas, 5 tons	204
Cowpeas, 2½ tons, + lime, 1,000 pounds	199
Cowpeas, 2½ tons	157
Manure, 10 tons, + lime, 2,000 pounds	155
Lime, 1,000 pounds	147
Manure, 10 tons	144
Lime, 2,000 pounds	140
Sodium nitrate, 200 pounds, + potassium sulphate, 200 pounds, + acid phosphate, 200 pounds	130
Sodium nitrate, 200 pounds	117
Acid phosphate, 200 pounds	113
Potassium sulphate, 200 pounds	106

The above table shows that this soil, although thoroughly cultivated, well supplied with commercial fertilizers, and subject to a systematic rotation of crops, in which cowpeas are frequently grown, has responded in a marked degree to many of the manurial treatments.

Cowpeas have produced decidedly the largest increase in growth, applications of 2½ tons and 5 tons giving increases of 57 and 104 per cent, respectively, and by supplementing this treatment with small amounts of lime, the gain has been increased to 99 and 138 per cent. The tops of young cowpeas were used in a green state, and the amounts given in the above table are calculated to water-free substance. Two and one-half tons of water-free tops per acre would be a good yield where cowpeas are grown for the purpose of plowing under as a green manure, although larger yields are sometimes secured. The roots of the cowpeas will probably equal about one-half the weight of the tops, and not only possess a manurial value, but have a marked beneficial effect upon the soil as a result of their extensive penetration. It is quite possible for the benefits derived from the roots and stubble of a crop of cowpeas to equal the benefits secured by plowing under the tops, and thus the tops may be removed for forage or hay and still the soil be improved.

Lime has also produced very marked results on this soil, giving increases of 47 and 40 per cent for applications of 1,000 and 2,000 pounds per acre, respectively. The same applications, when used in addition to cowpeas, produced gains over and above that resulting from the cowpeas amounting to 42 and 34 per cent, and when used in connection with a complete commercial fertilizer consisting of 200 pounds per acre each of sodium nitrate, potassium sulphate, and acid phos-

phate, the gain attributable to the lime is 77 and 75 per cent. It is noteworthy in this connection that the smaller amount of lime, i. e., 1,000 pounds per acre, has in each instance given slightly the larger increase. This seems to show that while the lime is very beneficial, the requirements of this soil are fully met by an application of 1,000 pounds per acre. Another striking thing in regard to the lime is that it has produced nearly twice as much gain when used with a complete fertilizer as when used alone, and, since commercial fertilizers are extensively used, this makes the application of lime all the more important. A complete commercial fertilizer as above used, costing a little more than $10 per acre, gave only a moderate gain of 30 per cent, and the addition of 1,000 pounds of lime, worth not more than $1.50, increased the percentage gain to 107. The financial side of this is too obvious to need discussion.

Barnyard manure has given a considerable increase, but from the economical standpoint is not equal to cowpeas and lime, and, furthermore, its use is restricted for want of supply.

RESIDUAL EFFECT OF FERTILIZING MATERIALS.

In order to ascertain what the residual effects of the treatments might be, a number of the baskets used in the experiments detailed in the above table were replanted without further addition of fertilizing materials. The following table gives the original treatments, and the lines represent graphically the comparative growth for both the first and second crops:

Comparative growth of wheat on Portsmouth sandy loam, for various treatments—first and second crops.

Fertilizing materials and quantity applied per acre.	Comparative growth.
Untreated	
Sodium nitrate, 200 pounds, + potassium sulphate, 200 pounds, + acid phosphate, 200 pounds	
Cowpeas, 2½ tons	
Cowpeas, 2½ tons, + lime, 1,000 pounds	
Cowpeas, 5 tons	
Sodium nitrate, 200 pounds, + potassium sulphate, 200 pounds, + acid phosphate, 200 pounds, + lime 2,000 pounds	
Sodium nitrate, 200 pounds, + potassium sulphate, 200 pounds, + acid phosphate, 200 pounds, + lime, 1,000 pounds	
Cowpeas, 5 tons, + lime, 2,000 pounds	
Fresh soil, untreated	

First crop ——— Second crop ———

It should be noted in the above table that a fresh untreated sample of soil was introduced in order to ascertain if the conditions during the growth of the second crop compared favorably with those which prevailed in case of the first. The untreated fresh soil gave a very slightly

greater growth than the original untreated sample gave for its first crop, thus showing that the conditions for the second crop were equally as favorable as for the first. The time of growth was identical.

The most striking feature about this test is the marked reduction in the growth of the second crop, which is frequently less than half what it was in the first instance. The relative growth as effected by the treatments is essentially the same in both crops, but there has been a marked reduction regardless of the treatment. In only two out of eight instances has the residual effect been sufficient to exceed or equal the original growth on the untreated soil.

It is a well-known fact in agriculture that continuous cropping with the same crop tends to diminish the yields, and it would seem most probable in case of the above experiment that the first crop left something in the soil that was harmful to the following one. The conditions in this regard were probably intensified from the rapid growth and heavy draft made on the soil in so short a time, and furthermore, the soil was replanted before time enough had elapsed for the oxidation or disappearance of the noxious substances, a change which probably occurs to greater or less extent in field practice, owing to the time which occurs between crops.

The results herein given by the wire-basket method seem to be thoroughly in accord with the observations that have been made in the field and with the experience of the planters in Darlington County. Arrangements have already been made for conducting field experiments on the plantation above referred to, for the purpose of determining if certain of the most beneficial treatments will prove equally as effective when tried under field conditions. The results are such as to justify the suggestion that farmers, particularly those who have this type of soil, should try in an experimental way the more promising applications herein reported.

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Approved:
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AUGUST 1, 1905.

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